

Jinjun Xue · Zhongxiu Zhao
Yande Dai · Bo Wang
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Foreword

March to a Low-Carbon Economy¹

Since the industrial revolution, human society has moved from the traditional low-carbon economy based on agriculture and animal husbandry to a high-carbon economy of industrialization based on fossil fuels. The high-carbon economy and the traditional path of industrialization have accelerated human development in terms of material prosperity and cultural civilization. But it also causes three key global environmental crises, namely, environmental pollution, ecological degradation, and global warming, which pose serious challenges to human sustainable development and civilization.

The United Nations Conference on the Human Environment in 1972 included global warming as one of the key challenges along with environmental and ecological degradation. It was the first time that global warming was listed as a priority on the global agenda.

During the UN Conference on Environment and Development in 1992, the United Nations Framework Convention on Climate Change (UNFCCC) was opened for signature. It marked a milestone of international consensus on climate change and the beginning of collective action as the UNFCCC came into effect.

As a veteran environmentalist with half a century's time devoted to environmental protection, I was privileged to have witnessed, as a member and as the deputy head of the Chinese delegations, respectively, these two historic moments when the international community and China made the decision to combat climate change.

In the past four decades, most notably at the turn of the last century, the human community has increasingly converged in efforts to combat global warming, particularly the emerging trend of low-carbon development and green development proposed by UNEP. Though controversies still exist about the precise definition of

¹ Qu is honorary professor at Peking University, Tsinghua University, Tongji University, Wuhan University, Nanjing University, and the People's University of China. Qu is also chairman of China Environmental Protection Foundation (CEPF). Qu was a pioneer in environmental protection issues in China.

low-carbon economy and green development, low-carbon energy and technologies have seen robust growth. The UK and Japan have proposed to develop low-carbon economies and low-carbon technologies and to reduce their CO₂ emissions by 60 % and 70 % percent, respectively, by 2050 based on their emission level in 1990. Though the US federal government has so far failed to implement robust mitigation policies, the development of renewable energy and technologies at the local level, driven by market force, is under way. South Korea has shifted to a low-carbon growth strategy. Many developing countries also are engaged in shifting from the high-carbon economy to a green growth approach by developing renewable energy.

China is also taking concrete steps toward a low-carbon economy. Chinese President Hu Jintao made solemn commitment to the world at both the APEC summit in September 2007 and the UN Climate Summit in September 2009 that China would “develop a low-carbon economy,” “promote the use of renewable energy and nuclear energy,” and “actively develop the low-carbon economy, the circular economy, and climate-friendly technologies.” China’s State Council also issued a National Climate Change program in September 2009. Simultaneously, China’s People’s Congress passed the Decision of Active Response to Climate Change and called for “the development of the green economy and the low-carbon economy based on China’s own situation.”

Coal consumption currently accounts for 70 % of China’s energy supply and contributes 70 % of SO₂, 50 % of TSP, and 80 % of CO₂. Therefore, China is working to optimize its energy structure and improve the efficiency of coal power in order to control both SO₂ and CO₂ emissions so as to realize the environmental co-benefits. Therefore, in terms of green low-carbon development, climate mitigation and air pollution mitigation are complementary to each other.

During China’s 11th Five-Year Plan (2005–2010), China’s energy intensity per unit GDP decreased by 19.1 %, which equals 0.63 billion t of coal equivalent. This achievement was China’s contribution to global mitigation efforts.

In the current 12th Five-Year Plan (2011–2015), green low-carbon development featuring clean production and the circular economy is the key theme. China has set three binding mitigation targets: non-fossil fuels will compose 11.4 % of primary energy consumption, energy intensity per unit GDP will be reduced by 16 %, and CO₂ intensity per unit GDP will be reduced by 17 %.

The Chinese government has made a commitment to reduce emission intensity per unit GDP by 40–45 % by 2020 relative to the 2005 level and that non-fossil fuels will make up 15 % of the primary energy mix. Realizing these two goals would represent the elimination of 7 to 8 billion t of CO₂ emissions by 2020 compared with the business-as-usual scenario. Though a challenging mission, it would bring about a revolutionary change in the Chinese energy consumption structure.

Both in China and globally, green low-carbon economy development will bring about fundamental revolutions in both energy and industry. China’s green low-carbon economic development is an inevitable path to new industrialization and scientific development. Green low-carbon economic development requires multi-player commitments. Stakeholders such as governmental agencies, enterprises, and

citizens have to share responsibilities and coordinate closely to achieve their common goal. The government should provide tax and financial incentives and regulatory guarantees to encourage enterprises to reduce their emissions. Enterprises are emitters, so they are obliged to shift their management and manufacturing approaches toward a low-carbon trend. Urban areas are the key emitting sources of CO₂, so they should build up low-carbon infrastructure building and management and encourage low carbon consumption. A number of pilot low-carbon cities should be set up as demonstrations for other cities to follow suit in the near future.

I was privileged to join the establishment ceremony for the Institute of Global Low-Carbon Economy last year upon the joint invitation of Jinxin Peng, a former colleague of mine at the Environmental Protection Agency, and Professors Shinichi Yamamoto and Jinjun Xue from Nagoya University. I am delighted to see the dynamic growth of the institute within this short period of time. The year of 2012 has seen the 40th anniversary of the United Nations Conference on the Human Environment, the 20th anniversary of the United Nations Conference on Environment and Development, and the 10th anniversary of the United Nations World Summit on Sustainable Development. The publication of *China's Green Low-Carbon Development* will show you some historical records of the efforts that China has made in carbon emission reduction in the past years. Therefore, I am honored and delighted to write this foreword for it.

Beijing

Geping Qu

Preface

China's Green Low-Carbon Economic Development is a series of studies on the theme of low-carbon economy, conducted and published annually by the Institute of Global Low-Carbon Economy (IGLCE.org), an international research platform cofounded by the University of International Business and Economics (UIBE), China, and Nagoya University, Japan. This book is the first time these works have been published in English.

In March 2011, when we were structuring and compiling this book, the Chinese government released its 12th *Five-Year National Economic and Social Development Plan*. Therefore, we chose the subjects of “green development” and “low-carbon economy” as key words to evaluate the success and problems regarding energy conservation and emissions reduction during the period of the 11th *Five-Year Plan*. For this purpose, the book focuses on reading and interpreting the green low-carbon development mode shift and relevant indicators of the 12th *Five-Year Plan*, as well as describing the trends of energy consumption, carbon emissions, environmental protection, and economic development in the next 5 years.

This book is characterized by the expertise of the authors, depth, realism, and forward-looking perspective. Each year we invite well-known world experts and scholars, including members of the IPCC working groups, negotiators of the United Nations International Climate Change Conference from various countries, government policy-makers, and experts and scholars in the field of low-carbon economy, to make contributions to the chapters. This year, we invited some leading experts from the Development Research Center (DRC) of the State Council of China, National Development and Reform Commission (NRDC), Chinese Academy of Sciences (CAS), and Academy of Social Sciences (CASS) who were involved in discussing and drafting the 12th *Five-Year Plan*. Using the latest statistical data, the experts give readers authoritative analyses of China's economic growth, development planning, energy strategy, carbon emissions, and other issues. These will provide references for a better understanding of the latest developments of the Chinese economy and prediction for the long term.

This book not only contains valuable data sets on climate change, carbon emissions, and energy consumption, but also detailed interpretation and analysis of various issues from experts and scholars. The reader will gain knowledge and

understanding of what is happening in the world and why these things are happening and how we should respond, and will be given inspiration and implications for making policies and decisions.

We closely follow domestic and international economic developments, focusing on the most pressing issues like the status of global climate change, the world energy strategy, and policy issues for renewable energy and low-carbon economic development; it shows progress and analyzes problems concerning the low-carbon economy in order to provide the latest information to readers.

The forward-looking perspective of the book gives experts' forecasts on important economic issues based on in-depth analysis. For example, on the energy issue, how fast will China's economy grow by 2015 and 2050? What fundamental changes will be undertaken in terms of the industrial structure? How much energy will be demanded? How much carbon emissions will occur by 2015? Will the target of reducing carbon emissions by 40–45 % be achieved? All of these questions are analyzed, making this book an important reference for studying the Chinese economy and for policy-making.

The following highlights are addressed in this year's book:

First, the book reviews and evaluates the main achievements of energy conservation and pollution control in recent years in China, especially during the period of the 11th *Five-Year Plan*. According to IEA, China's carbon dioxide emissions accounted for 23 % of the world's total emissions, and China surpassed the USA as the world's largest emitter in 2009. At the same time, China became the world's second largest economy in 2010. From this perspective, the book points out that China should assume greater responsibility for emission reductions. However, the outside world holds an image of China as a heavy emitter but, due to less media attention, has no further information about what China has done to reduce carbon emissions. In fact, China has already made great efforts for emission reduction; for example, between 2005 and 2010, China's energy intensity (energy consumption per 100,000 Yuan GDP) decreased by 19.1 %, saving 630 million t of coal, equal to 1.5 billion t of carbon dioxide emissions. Such a large emission reduction is definitely a major contribution China has made to the world, and it shows that China is taking the lead in carbon emission reductions (Chap. 1).

Second, we interpret the 12th *Five-Year Plan* from the point of view of energy conservation and carbon emission reduction, new energy strategy, environmental protection and ecological balance, low-carbon city construction, etc. We also decompose the indicators of energy conservation and emission reduction as well as environment and ecology, describe the blueprint of China's green development, make authoritative analyses of the latest trends of low-carbon development, and give policy implications to policy-makers.

The book points out that the core of the 12th *Five-Year Plan* is to accelerate the fundamental transition of the development mode to achieve "green low-carbon development." In order to implement this route, the 12th *Five-Year Plan* proposed a series of binding targets, like "bring the share of non-fossil fuels in primary energy consumption to 11.4 %, reduce energy consumption intensity (energy consumed per 100,000 Yuan GDP) by 16 %, and reduce carbon dioxide emissions

intensity (carbon volume emitted per 100,000 Yuan GDP) by 17 %.” Unlike the 11th *Five-Year Plan*, here the “emission reduction” in the “energy saving and emission reduction” targets not only refers to reducing the emissions of environmental pollutants such as sulfur dioxide, but also includes the emissions of carbon dioxide; therefore, after achieving these goals, the emissions of carbon dioxide and other pollutants will be significantly reduced in China, enabling the realization of a fundamental transition in China’s economic development mode.

The book stresses that these indicators will guarantee that the Chinese government will fulfill its promise to reduce carbon emissions per unit of GDP to 40–45 % below 2005 levels by 2020. Assuming a 7 % annual economic growth rate proposed by the “12th FYP” and using the carbon emission intensity in 2005 as a base, this target means that by 2020 there will be 7 billion t of carbon dioxide reductions. This will be a significant result, and no country except China can achieve this.

Third, the book analyzes the status quo of China’s energy supply and demand and describes the short-term energy development road map for the next 5 years and a longer-term plan for the next 15 years. The book points out that, along with rapid economic growth and steady improvement in people’s living standards, China’s energy demand has been experiencing unprecedented rapid growth. In 2010, the total energy consumption in China reached 3.25 billion t of coal equivalent, 1.2 times more than the level in 2000. China is relatively rich in oil resources: its accumulated oil reserves at the end of 2010 were 31.28 billion t as measured by the geologically explored amount, 3.14 billion t as measured by the surplus recoverable technology measure, and 2.043 billion t as measured by the economically productive measure. However, due to the energy demand greatly exceeding supply, China has changed from an oil-exporting country to an oil-importing country. In 2010, China’s oil dependence reached 54.8 %, and China became a country which needs to import all forms of primary energy except electric power. This has contributed to a high dependence on energy imports, which in turn increases the risks to China’s energy security.

The book notes that the 12th *Five-Year Plan* has set the average annual growth target for economic development for the next 5 years at 7 %, but most experts predict that the actual development trend in the average annual growth rate of China’s GDP in the next 10 years is likely to reach 8.5 %. This means that by 2020 China’s GDP will reach 71 trillion Yuan (in constant 2005 prices), and primary energy demand will reach 7.1 billion t of coal equivalent when calculated using the energy intensity of the 11th *Five-Year Plan*; in terms of energy supply capacity, environmental protection, the response to global warming, and other aspects, China’s sustainable development would face very severe stress. However, if China strictly implements energy saving and emission reductions to decrease its energy consumption intensity per unit GDP by 30 % over the next decade, then the total primary energy demand will be reduced to 5.1 billion t of coal equivalent, which would save 2 billion t of coal, equivalent to a reduction of 4.70 billion t of carbon dioxide emissions. The book also points out that in recent years, China’s green energy has been developing at an unprecedented speed: the growth rate of installed capacity of hydropower, the utilization of solar water heaters, the scale of

under-construction nuclear power, and the installed capacity of wind power all rank number one in the world. The Chinese government has also developed a more ambitious goal for green energy development: increasing the usage of non-fossil energy to the equivalent of 700 million t of coal equivalent. Given the base of 277 million t of coal equivalent in 2010, the usage of non-fossil energy will therefore increase by at least 400 million t of coal equivalent, thereby helping to alleviate to some extent China's energy demand crisis in 2015.

At a time when all local governments and departments are decomposing the indicators of the 12th *Five-Year Plan* and developing specific implementation plans, we bring experts in various fields and government officials together; set "green" as the theme; read and interpret the 12th *Five-Year Plan*; make authoritative analyses of China's green development, energy conservation and emission reduction, as well as the latest trends for future economic development; and make policy recommendations based on all of the above. We believe that this book will not only provide more valuable data on carbon and energy and policy interpretations, but will also be an important reference for government officials, policy-makers, researchers, businesses' strategic decision-makers, analysts of the international situation, students, and the general public.

Nagoya, Japan
February 1, 2013

Jinjun Xue

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Jinjun Xue and Xiaowei Xuan

Abstract

On becoming the world's second largest economy, China also tops the world in CO₂ emissions, and severe environmental pollution becomes a huge cost of China's speedy economic growth. Issues of environmental pollution and carbon emissions make China the focus and target of international talk and criticism as it increasingly gains international influence. However, people may don't know the facts that China's emission reduction actions are the strictest and its enforcement is the strongest in the world. Statistical data shows that during the 11th Five-Year Plan, China's energy/GDP ratio decreased by 19.1 %, the shares of non-fossil energy consumption rose to 8.4 %, national chemical oxygen demand decreased by 12.5 %, and emissions of SO₂ dropped by 14.5 %. Objectively speaking, China reduces and achieves the most in the world.

The 12th Five-Year Plan for National Economic and Social Development proposes that China will accelerate the "transformation of economic development mode" and take "green development", "Circular economy", "low carbon technology", and "sustainable development with environmental and ecological protection as the new direction of future national development. The idea of "green development" raised by the 12th Five-Year Plan is a significant turning point in China's economic development and will fundamentally change China's economic and social development mode and produce lasting and deep influence in the world.

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Keywords

The 12th Five-Year Plan • Green development • Low-carbon economy • Index decomposition of the 12th Five-Year Plan

1.1 Introduction

In addition to being the world's second largest economy, China discharges the most CO₂ in the world. Issues of environmental pollution and carbon emission make China the focus and target of international criticism as it increasingly gains international influence. Thus, energy-saving and emission-reduction become China's obligations. As China is leading the world economy, it must also lead the reduction of world emissions and contribute to a green world. Meanwhile, China's efforts and contributions on emission reduction need proper judging as well. In actuality, China has reduced and achieved the most of all countries in the world. Within 5 years China has realized its target of saving 20 % of energy and reducing 10 % of the major pollutant emissions. This is the biggest contribution that China has made to the world's emission-reduction campaign and response to climate change.

The 12th Five-Year Plan of China proposes a program of "Green and Low-Carbon Development", which requires that non-fossil energy occupy 11.4 % of primary energy consumption, energy/GDP decrease by 16 %, and carbon emission/GDP decrease by 17 %. Realization of these restrictive targets will fundamentally transform China's economic development mode and significantly impact the world economy at large.

This chapter focuses on three aspects of energy, environment, energy-saving and emission-reduction. It will answer the following questions: What has China achieved during the 11th Five-Year Plan? How? How does the 12th Plan differ from the 11th? What are the major targets of green development (for example, energy, low-carbon economy, and environment) in the 12th Five-Year Plan? How can China realize these targets? And what are the policies?

In 1980, the father of China's Reform and Opening-up, Deng Xiaoping, put forward the idea that China should "double its national income" after referencing Japan's "National Income Doubling Plan". Since then, the income of Chinese citizens has doubled, or even quadrupled, every 10 years. In the 30 years from 1980 to 2010, China's GDP grew by 9 % annually and in 2010, China surpassed Japan to become the world's second largest economy. Its export volume has also surpassed that of Germany and become the largest in the world. The IMF predicted in its *World Economic Outlook 2011* that if China continues its high-speed growth and the US stagnates, China would overtake America as the world's largest economy in 2016, much faster than most economists and international organizations have predicted (*Wall Street Journal* Japanese version, April 26, 2011). Meanwhile, China's GDP per capita increased from US\$ 313 in 1980 to US\$ 4200 (World Bank, *World Development Report 2011*). The 12th Five-Year

Plan for the National Economic and Social Development, passed by the 11th National People's Congress in March 2011, clearly pointed out that GDP per capita should be doubled again, to US\$ 8,400 by 2015.

Nevertheless, China pays enormous costs for its rapid growth. China faces severe environmental pollution problems and has become the largest pollution source in the world. Environmental pollution and ecological destruction result in grave disasters, and trans-boundary pollution has become an international issue. China, famed as "the world's factory", is also criticized as the country that most pollutes the world's environment and emits the most greenhouse gases. It is predicted that China will sustain its growth at a moderate rate in the coming decades and will emit 128 tce tons of carbon equivalent in 2030, making up 30.5 % of the global total amount (IEA 2009). This is the biggest negative externality resulting from China's rise.

In terms of energy consumption and carbon emissions, the Chinese economy is traveling on a road of high consumption and high emissions, that is, a "high-carbon economy". According to the newest statistics of IEA in 2011, China's CO₂ emissions accounted for 22 % of the world's total in 2008, passing America as the No. 1 emitter. This share is more or less proportional to China's population, which makes up 19 % of the world's population (2011), and its position as the second largest economy in the world. Moreover, a considerable amount of the carbon emissions is produced by foreign companies which manufacture in China and sell products outside China. After all, China's GDP is only 9.5 % of the world's gross product value (2010) and 16 % of the world's total industrial output. As a developing country with income per capita of US\$ 4,200, 22 % of emissions is a quite large share and it will rise as China's economy continues to expand (Source: website of the National Bureau of Statistics of China).

Issues of environmental pollution and carbon emissions make China the focus and target of international criticism as it increasingly gains international influence. However, the more serious problems come from China's internal pressure from environmental loads, energy shortages, and carbon emissions. According to Chinese scholars and government decision-makers, in the coming two or three decades, China will strive to open up "a road to rapid industrialization", and try to compress the industrialization process, which took more than a century in developed countries, to a rather shorter period. It will gradually complete industrialization and urbanization and raise living standards and service levels for billions of Chinese people to the standard of a moderately developed country. Thus, the increase of energy consumption and carbon emissions will multiply in China. The question is whether China's resources and environment can live up to the enormous need of its economic growth. China also faces huge international and domestic pressure on issues of climate change, energy-saving and emission-reduction. The Vice Director of the Energy Research Institute of the National Development and Reform Commission, Dai Yande, has found in his research that energy supply and demand in China are changing dramatically. In the medium and long term, conventional oil and gas will decline, while the development of transportation substitute fuels will witness significant improvement and renewable energy will grow rapidly. These

changes undoubtedly increase the uncertainty surrounding China's long term energy demand and carbon emissions. To turn China into a well-off society in an all-around way and a moderately developed country by 2020, without reinforced emission reduction policies, China's total energy demand and carbon emissions will still multiply and even with energy saving efforts the increase will only slow down after 2035 [4].

In short, the world's energy safety, international pressure on emission-reduction, and huge domestic demand compel China to abandon the old development pattern of "high pollution and high emissions" and develop a distinct industrialization path of low-carbon and green development. In this context, the "12th Five-Year Plan for the National Economic and Social Development" pointed out that China must speed the "transformation of its economic development mode" and take "green development", "recycling economy", "low-carbon technology", and "sustainable development with environmental and ecological protection" as the future guidelines of national economic development.

1.2 China Needs Green and Low-Carbon Development

1.2.1 China's Economic Miracle

The World Bank reported in 1997 that rapid growth and relative equal income distribution in Asian countries and regions like Japan, South Korea, Singapore, Taiwan, and Hong Kong can be titled "the East Asian Miracle" (World Bank, *The East Asian Miracle*, 1997). Since China's reform and opening up in 1978, it has witnessed violently rapid economic development and is creating another Asian miracle. Table 1.1 compares the GDP of Asian countries and regions during their high-speed development. It shows that China's economic development is the most vigorous and lasting.

Meantime, per capita income in China increased from US\$ 313 in 1980 to US\$ 4,200 in 2010, or about US\$ 7,400 at purchasing power parity (Fig. 1.1).

1.2.2 China's "Black Growth"

China has paid an enormous cost for its rapid development. It has severe environmental pollution and has become one of the biggest pollution sources in the world. Professor Hu Angang of Tsinghua University, an expert of the National Conditions Study, has called growth at the expense of environment "black growth".¹ He stated that China was one of the most polluted countries in the world, and could be called a

¹ Hu Angang (2011) Low-Carbon Political Economy, in Xue Jinjun eds. *The Economics of Low-Carbon*, Social Science Academy Press.

Table 1.1 International comparison of high-speed growth

Countries/regions	Period	Year	Annual growth rate
Japan	1958–1973	15	9.7
	1973–1988	15	3.6
	1988–1993	5	3.0
South Korea	1962–1977	15	9.6
	1977–1987	10	8.0
	1987–1995	8	8.1
China Taipei	1962–1977	15	10.1
	1977–1987	10	8.7
	1987–1995	8	6.6
Mainland China	1978–1996	18	10.6
	1981–1990	10	9.4
	1991–2000	10	10.1
	2001–2005	5	9.5
	1978–2010	30	9.0

Source: Japan’s Economic Planning Agency “Asian Economy” 1996; *China Statistical Yearbook 2011*

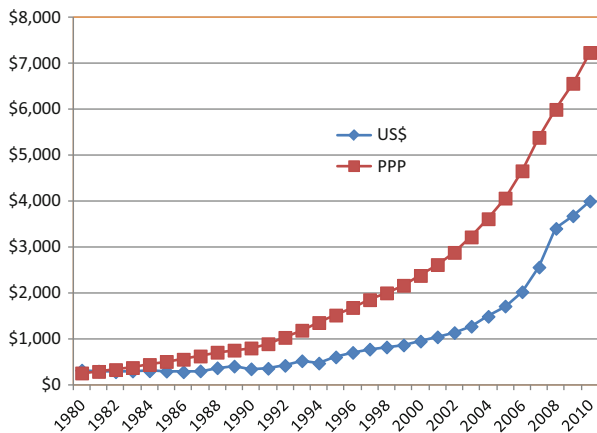


Fig. 1.1 China’s GDP per capita (Source: Xue Jinjun, based on IMF *World Economic Outlook 2011* and CIA and World Bank, *World Development Indicators 2011*)

“black cat” [2]. At present, China’s emissions of organic wastewater, sulfur dioxide, and various greenhouse gases top the whole world.

Even more seriously, China’s environmental pollution has never been fundamentally controlled. Figure 1.2 shows the Kuznets Curve of China’s environmental pollution. It displays that from 1980 China’s pollutant emissions (represented by SO₂) accelerated despite a small decline in 2007, and the peak value of pollutant emissions still cannot be confirmed as a turning point because of the temporary

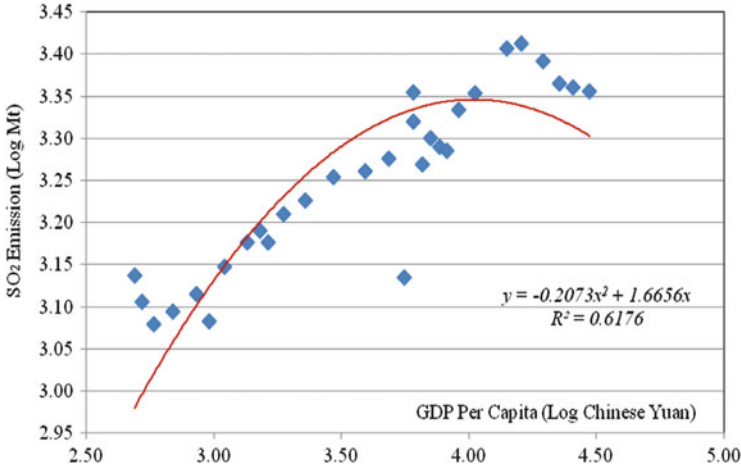


Fig. 1.2 Kuznets Curve of China's environment (Source: Xue Jinjun, based on *China Statistical Yearbook 2011*)

effects of some special measures taken by the central government together with the problems of concealment and missing statistics. Therefore, the prospect of reducing environmental pollution is discouraging.

Hu warned that China was the biggest victim of environmental pollution. The 1.3 billion Chinese people are the poorest sufferers of various environmental pollutions, which especially affects their health. According to statistics from the International Institute of Applied System Analysis (IIASA), China's national gross life loss resulting from man-made particle pollution is the highest in the world. It reached 1.163 billion person-years in 2005, which reduces the average life expectancy in China by 0.89 years. In 2035 it will reach 1.573 billion person-years, which would reduce the average life expectancy by 0.245 years if China's population were 1.462 billion then. What large figures for national life loss and GDP damage!

In addition, China is one of the countries with the largest area exposed to acid rain, and billions of Chinese people are victims of air pollution. Coal is the biggest source of China's air pollution and the biggest killer of people's health. According to World Bank statistics, China is the country that emits the most sulfur dioxide in the world. China has 20 of the 30 most pollutant cities in world. As WHO predicted, China had about 380,000 people who die from air pollution caused by solid fuel burning (International Energy Agency, *World Energy Outlook 2007: China and India Insights*). According to a report of the OECD, health loss caused by air pollution will be equivalent to 13 % of China's GDP until 2020.

As a matter of fact, environmental problems have broken out frequently in recent years. It's easy to find events on the internet, such as the "Songhua River Pollution Problem" of 2005, the Sanlu Milk Incident of 2009, the "Cancer Village" in Guangdong Province reported by CCTV in 2010, the "Harbin Pharmaceutical

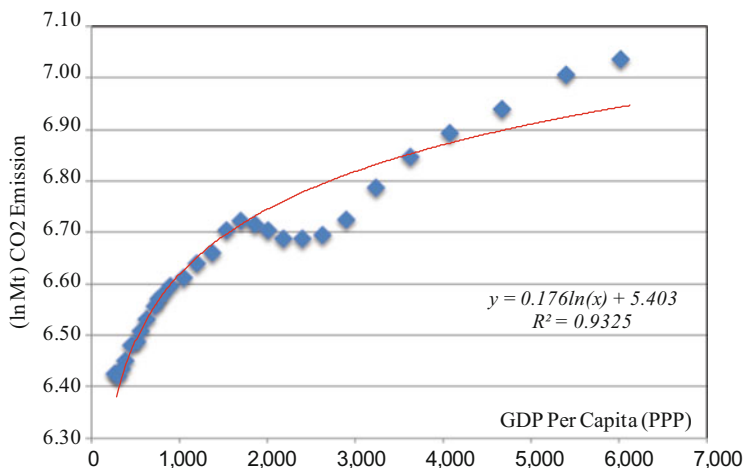


Fig. 1.3 Kuznets Curve of China's carbon emission (1980–2009) (Source: Draw by Jinjun Xue based on the data from *OECD/IEA, CO₂ Emission From Fuel Combustion Highlights 2010*)

Factory Pollution Incident” of 2011, “Watermelon with Swelling Agent”, and the “Heavy Metal Poisoning Incident” in Shaanxi and Hunan, etc. Like Japan, where rapid growth left behind environmental problems for a long time, environmental pollution and public nuisance diseases in China are revealing and more noticeable than those in Japan because information is open, media disclosures occur, and scientific test techniques disseminate.

Above all, China pays a huge cost for its speedy growth. Research in *Nature* estimated that environmental pollution had cost nearly 10–15 % of China's GDP.² Environmental pollution and ecological damage, especially transboundary pollution, have become an international issue.

1.2.3 China's “High Carbon Economy”

Looking back on the history of China's economic development, we find that China's economic development follows a path of high energy consumption, i.e., a “high carbon economy”.³ Figure 1.3 shows the Kuznets Curve for China's total carbon emissions; from 1980 to 2008, carbon emissions in China jumped dramatically. Regarding the long term tendency, carbon emissions are far away from the peak value, which means there's a long way to go to get to the turning point. It indicates that even though the Chinese government made an environmental

² Liu Jianguo and Jared Diamond (2005), “China's environment in a globalizing world,” *Nature*, Vol. 435.

³ *The Economics of Low-Carbon*, Social Science Academy Press.

commitment at the Copenhagen Conference, that relative to 2005 levels China would reduce carbon emissions/GDP by 40–45 % by 2020, total carbon emissions will still climb.

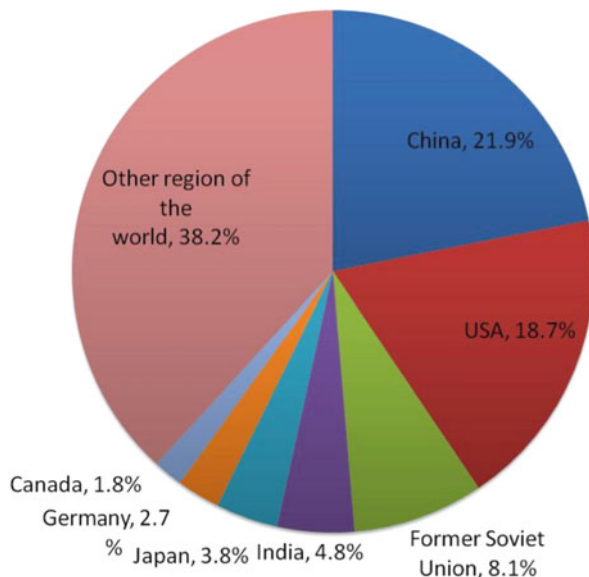
The newest carbon emission statistics publicized by IEA reveals that China's emissions per capita is 4.6 t CO₂; the US figure is 19.8 t, 4.3 times that of China. However, China's carbon emissions make up 21.9 % of the world's total, surpassing the 18.7 % of the US and topping the rest of the world. At the same time, China leaves Japan, India, Brazil and so on far behind in carbon emissions. Its total amount will rise to 8.632 billion tons in 2015 and reach 8.9 billion tons in 2020, and 12.8 billion tons in 2030, at which point it will account for 30.5 % of the world's total and 52 % of the global increase until then. China therefore becomes the focus and target of international talk and criticism as it increasingly gains international influence.

1.2.4 China: The Biggest Victim of Global Climate Change

Why should China actively respond to global climate change? Ross Garnaut, climate change advisor for the Australian Government, the author of *Global Climate Change Review*, and the former ambassador to China, insightfully pointed out that China's efforts on climate change were not only forced by international pressure, but more by its own need. Chinese scientists have found out that, like Australia and other Asia-Pacific neighbors, the crisis confronting China is more severe than that facing the developed countries. For instance, the potential disappearance of the glacier in the Qinghai-Tibetan Plateau provoked wide concern in China's scientific community. It might destroy those big rivers that have had stable water flow for thousands of years. Particularly, the Yangtze River and the Yellow River, praised as cradles of the Chinese people and civilization, will bear the brunt of the impact. Second, water loss and soil erosion will impact irrigation and temperature rise will greatly threaten farming in the North China Plain. Third is the threat of rising sea level, which will influence economic activities of those frontier cities in the reform and opening up, including the Pearl River Delta, Shanghai and its outskirts, Ningbo, Tianjin, and so on, since they are situated in coastal lowlands. Because rivers with wide flow coming from the Himalayas in the Tibetan Plateau flow together into the sea, the sea level will rise. Therefore, like Australia, China has to share the flood with its South Asian and Southeast Asian neighbors (Fig. 1.4).

Climate change will lead to an increase in natural disasters and China is a country with the gravest disasters in the world. Recently, drought hit Northwest and North China frequently and also widely attacked Northeast, Southwest, and South China. Two thirds of the nation's land is under the risk of flood and more and more places suffer from elevated temperature and heat waves. Between 1990 and 2009, direct losses from natural disasters amounted to 2.48 % of China's GDP, or 20 % of the annual GDP increase. The denser the economy and population in

Fig. 1.4 Carbon emissions of major countries in the world (2009) (Source: Jinjun Xue, based on OECE/IEA, *CO₂ Emissions from Fuel Combustion Highlights 2011*)



cities and regions, the greater the harm and loss will be. China is the biggest victim of global climate change.⁴

1.2.5 China Faces Serious Energy Shortage

From detailed statistics of energy consumption and production, China's national total energy consumption reached 3,066 Mtce in 2009, breaking through the target of 3,000 Mtce for 2020 proposed in the *Medium and Long Term Development Planning of Energy 2004–2020* (passed by the State Council Executive Meeting) 11 years ago; in 2010 the national total energy consumption exceeded 3,200 Mtce, which also broke through the target of 2,700 Mtce for 2010 set in the Energy Development Planning of the 11th Five-Year Plan by 0.5 billion tons; even if it is controlled at 4 billion tons by 2015, national energy consumption will still increase by 4.6 % per year in the coming 5 years (2011–2015), above the world's average growth rate. China is not only the biggest energy consumer, but also the country which contributes the most to energy consumption growth. During 2008–2015, the increase in China's energy consumption will account for half of the world's increase (see Table 1.2); following this tendency, China's energy consumption will jump to over 5,000 Mtce by 2020 [1].

⁴Ross Garnaut, Low-carbon National Economics, in Xue Jinjun eds., *The Economics of Low-Carbon*, Social Science Academy Press, 2011.

Table 1.2 Energy consumption and CO₂ emissions in China (2000–2015)

Year	Energy consumption (100 Mtce)	Coal consumption (100 Mtce)	CO ₂ (billion tons of CO ₂ equivalent weight)
2000	14.6	14.1	–
2008	29.1	28.1	6.55
2009	30.7	29.7	6.85
2010	32.1	32.0	7.17
2011	33.5	33.5	7.51
2012	35.0	35.0	7.85
2013	36.6	36.6	8.22
2014	38.3	38.3	8.60
2015	40.0	40.0	9.00
Annual growth (2008–2015)%	4.65	5.2	4.64
Total amount of the 12th plan (2011–2015)	183.5	185.4	411.8
Share of the world in 2015(%)	20.96	48.3	27.16
Multiple of the US in 2015	1.27	3.45	1.63
Share of world's increase during 2008–2015(%)	50.23	80.8	67.31

Source: Data about coal consumption come from the website of National Energy Bureau of China; energy consumption data are drawn from *China Statistical Abstract 2010* and website of the National Energy Bureau; CO₂ emissions are calculated by Hu Angang based on IEA and WTO statistics

Note: Data of 2010–2014 is estimated upon the fixed annual growth rate

Though China has taken unprecedentedly strict energy saving measures, it still has to make great efforts to realize its target for 2020. The 12th Five-Year Plan for National Economic and Social Development proposed that the annual GDP growth rate be 8 % and that the income per capita be doubled by 2020 (according to US\$ 4,200 in 2010, it will reach US\$ 8,400). To achieve those targets demands enormous energy and will bring about more environmental impacts. The huge demand for energy and pressure on the environment is increasing and becoming a bottleneck restraining and slowing down economic development in China. Therefore, responses to global climate change, energy saving and emissions reduction, improvements on environment and ecology, and green development are not only the results of pressure from the international community but also of China's future development need.

1.2.6 China Should Lead the World in Emissions Reduction

Ross Garnaut indicated in *Low Carbon Economy* that, “In the current world, policies at any level and any influential global campaigns cannot do without China's participation. Simply looking upon China's importance in international

politics and economy, it is quite evident. Since the reform and opening up, its importance has been building up daily and it has become more striking from the start of the twenty-first century.” He also pointed out, “We are in a special world in which China’s international commitment is of crucial importance to a good result of slowing down climate change. Currently those encouraging policies that China has made to deal with climate change largely match the strong international demand of slowing down climate change. All in all, China integrating its domestic policies into the international commitment will completely change the result of the global efforts to deal with climate change”

Gary Locke, former US Energy Minister and present ambassador to China, interviewed by *Global Times* (July 16, 2009), said that America and China’s leading efforts on emission reduction would largely determine the future fate of the world. China plays a decisive role in emission reduction and probably is the country of utmost importance. Hence, despite having lower per capita emissions than developed countries, China should work together with the other five countries that emit the most greenhouse gases to reduce its emissions in the first place.

Hu Angang has also pointed out that when China has become the largest beneficiary and driver of economic globalization and the biggest stakeholder in global public interests, any acts of China, including economic development and pursuit of national interests, should not work at the expense of humanity’s common interests. China’s public commitment to emission reduction informs the whole world that China is willing to protect the common home of human beings, the earth, via mutual help and coordinated efforts with the rest of the world. Just as the 15th Political Bureau of the CCP, overriding all objections, decided to enter the WTO, China taking the initiative to promise emission reductions is another significant decision.

1.3 China Actively Responds to Climate Change

1.3.1 China’s Attitude Towards Climate Change

Chinese leaders have declared on different occasions that China would actively respond to global climate change and develop a low carbon economy. Since 1998, China has enacted a variety of laws and regulations related to climate change and low carbon economy and taken enormous measures. In 2009 China publicly promised the international community at the Copenhagen Conference that China would reduce its carbon emissions/GDP by 40–45 % by 2020 relative to 2005. In 2010, the National Development and Reform Commission designated five provinces and eight cities as pilot sites of developing low carbon cities and industries. In 2011, the 12th Five-Year Plan explicitly proposed that the development mode should be transformed rapidly and that green and low carbon development should be realized; it also set up a series of restrictive targets for energy saving and emission reduction. All the above indicate that China is actively responding to

climate change, and also exhibit China's determination and action to keep its word on its international commitment and national economic development goal via low carbon development.

1.3.2 China's Targets for Energy Saving and Emission Reduction

During the 11th Five-Year Plan period (2006–2010), for the first time, China set up restrictive targets for energy saving, that is, “a 20 % reduction in energy/GDP”. Moreover, it decomposed that goal layer by layer, with target responsibility letters signed; it distributed the national target into specific regions, industries, and even key companies, and took strict examination measures to achieve the targets.

The reason that China has been taking such strict measures to have the target realized is that China wants to speed the transformation of its development mode by making and enacting energy saving targets. The traditional pattern of development has features of “high input, high consumption, and high emissions”. The low cost competition mode, which underestimates the factor value of land, water, resources, energy, and the environment, resulted in huge successes in development in the past 30 years, but also created unsustainable problems. Hence, as early as the 9th Five Year Plan (1996–2000), the Central Committee of CCP upheld the slogan of transforming the mode of economic growth. However, in the existing institutional arrangements, especially with the price twists of resources and sharp competition among local governments, it has been impossible to go far in transforming the mode. This was particularly true during the 10th Five-Year Plan (2001–2005) as China ushered in a new wave of quick development: heavy industries, steel, metallurgy, and petrochemical industries with high energy consumption were developed in leaps and bounds across the country. Energy/GDP turned from the declining curve of the past into a climbing line. The environmental pressures confronting China jumped dramatically at the same time. Therefore, during the 11th Five-Year Plan (2006–2010) there had to be policies driving different regions, sectors, and industries to take feasible specific actions to reverse the environmental and ecological deterioration and increasing environmental pressure of resources, and to promote a fundamental transformation of the development mode. In the 11th Plan, the restrictive target of a “20 % reduction of energy/GDP” came into being in the above context.

1.3.3 China's Actions of Energy Saving and Emission Reduction

In the past 5 years (2006–2010), focusing on the 20 % target, governments at different levels, different sectors, major industries and companies all adopted a series of relevant policies and measures, like “responsibility contract for energy saving and emission reduction”, “promoting the large and holding the small”, “Top-1000 Energy-Consuming Enterprises Program”, etc., resulting in good performance. During the 11th Five-Year Plan, China's energy/GDP declined by 19.1 %, reaching the basic requirement of the plan. However, measures targeting

energy intensity during this period also revealed noticeable problems. For instance, regional differences were not taken into consideration in target distribution; there was also over-dependence on government actions while downplaying the role of markets. Due to the lack of experience in implementing policies related to energy conservation, local governments underestimated and poorly prepared for difficulties and hardships. Therefore, in the second half of the 11th Plan period, as the pressure of realizing the targets across the country was building up, many places were unable to complete the task and some local governments were forced to take extreme measures like “power rationing” and “abrupt shutdown of heating”. These methods not only run counter to establishing a long-term mechanism of energy saving and emission reduction, but also are unable to stimulate a real transformation of the development mode. Hence, the energy saving target of the 12th Five-Year Plan on the one hand set a lower energy intensity target at 16 % instead of 20 % in order to release the difficulties of completing the task regions taking regional differences into full consideration and categorizes the targets.

Many may know that China is the largest carbon emitter, but few know that China also reduces and achieves the most in emission reduction. Ross Garnaut has made penetrating remarks that China actually has done a lot in dealing with climate change. But little is known because China didn't integrate itself into the international system in this aspect.

As a matter of fact, China's reduction actions are the strictest in the world and its enforcement is the strongest. No one else dares to propose the targets of a 20 % reduction of energy consumption and emission in 5 years and a 10 % reduction of major pollutants. The following section introduces the policies and achievements of energy saving and emission reduction during the 11th Plan. It is no exaggeration that only China can take such measures, and only China can achieve so much within such a short time.

China is a socialist market economy, which indicates that China is a market economy with national authority over it. In other words, China's economy is market-conforming, but the Chinese government and economic planning play an important role. On the issue of climate change and energy saving and emission reduction, China implements forceful policies from the top down. This is the very foundation upon which the achievements of the 11th Five-Year Plan were completed:

1. Eliminating outdated industrial capacity (promoting the large and holding the small, closing down, suspending operation, merging or rationalizing): in 2007, China adopted programs of constructing big power units while closing down small ones in the power industry and closing down and eliminating outmoded production capacity in the steel industry; these programs covered 13 industries including thermal power, steel, cement, coal, and so on. In 2008, the program continued, with central government financial support of 6.2 million yuan for employee settlement and production switches. In 2009, the program of constructing big power units while closing down small ones shut down small thermal power units of 15 MW, eliminated backward iron-making production